CHP and the Greening of the Grid

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Critiques of CHP Ability to Reduce GHG Emissions

As the electric grid becomes cleaner and greener, the emissions reduction potential of CHP has come into question.

- More efficient stand alone electric generation
  - 31% increased to 47%
- Renewable Portfolio Standard
  - California 33% of energy by 2020
  - CHP Displaces Renewable Capacity
- GHG Intensity of the California Grid Declines
  - Metric tons of CO_2e per MWH

Relationship between GHG Intensity and CHP GHG Savings

Table 1. Estimated GHG Savings from SCE's Existing CHP Fleet

	Mid 1990's	Today	2020	New CCGT	*EPA CPP*
Implied Heat Rate	9,402	8,547	7,692	7,000	4,906
GHG Intensity	1100	1000	900	819	574
Boiler Efficiency	80%	80%	80%	80%	80%
CHP Efficiency	65%	65%	65%	65%	65%
Power-Heat Ratio	0.8	0.8	0.8	0.8	0.8
GHG Savings (%)	55%	39%	23%	10%	-29%
GHG Savings (MMT)	2.2	1.5	0.9	0.4	-1.1

Critique of the CHP Critiques

These critiques of the ability of CHP to reduce GHG emissions are based on engineering type studies, formulas based on generic relationships between CHP factors and GHG intensity, or rule of thumbs that are based on implicit assumptions about the interaction of CHP with the other types of generation resources.

"Estimating the energy and emissions displaced by CHP requires an estimate of the nature of generation displaced by the CHP system. ***Accurate estimates can be made using a power system dispatch model*** to determine how emissions for generation in a specific region are impacted by the shift in the system demand curve and generation mix resulting from the addition of new CHP system." (Williams, p. 14)

Production Cost Simulation - 2021

Chronological - Hourly Dispatch to Minimize System Production Cost

23 transmission areas

2,614 generation units

63 hydro units , 9 pumped storage, 3 battery storage

Demand Forecast – December 2013 CEC 2014-2024 Final Forecast

Mid Energy Demand Scenario

Mid Additional Achievable Energy Efficiency Scenario

Coincident Peak 65,010 MW

Net Energy Load plus Losses 297,108 GWH

33% RPS Fully Implemented - 21,799 MW Solar, 6,709 MW Wind

OTC - 11,744 MW Old Steam Replaced with 1,750 MW of CC and 2,200 MW GT

NEW CHP Additions

ICF Tables D8-11: Cumulative Market Penetration (MW) Medium Case - 2020

Utility	50-500 kW	500-1000 kW	1 - 5 MW	5-20 MW	>20 MW	Total	% of Total
LADWP	10.30	21.40	58.20	56.60	157.10	303.60	11.37%
PG&E	93.50	56.50	218.40	174.10	972.50	1515.00	56.73%
SCE	10.80	29.20	123.10	132.30	325.40	620.80	23.25%
SCG&E	15.70	14.40	45.60	33.60	121.70	231.00	8.65%
Total	130.30	121.50	445.30	396.60	1576.70	2670.40	
Percent	4.88%	4.55%	16.68%	14.85%	59.04%	100.00%	100.00%

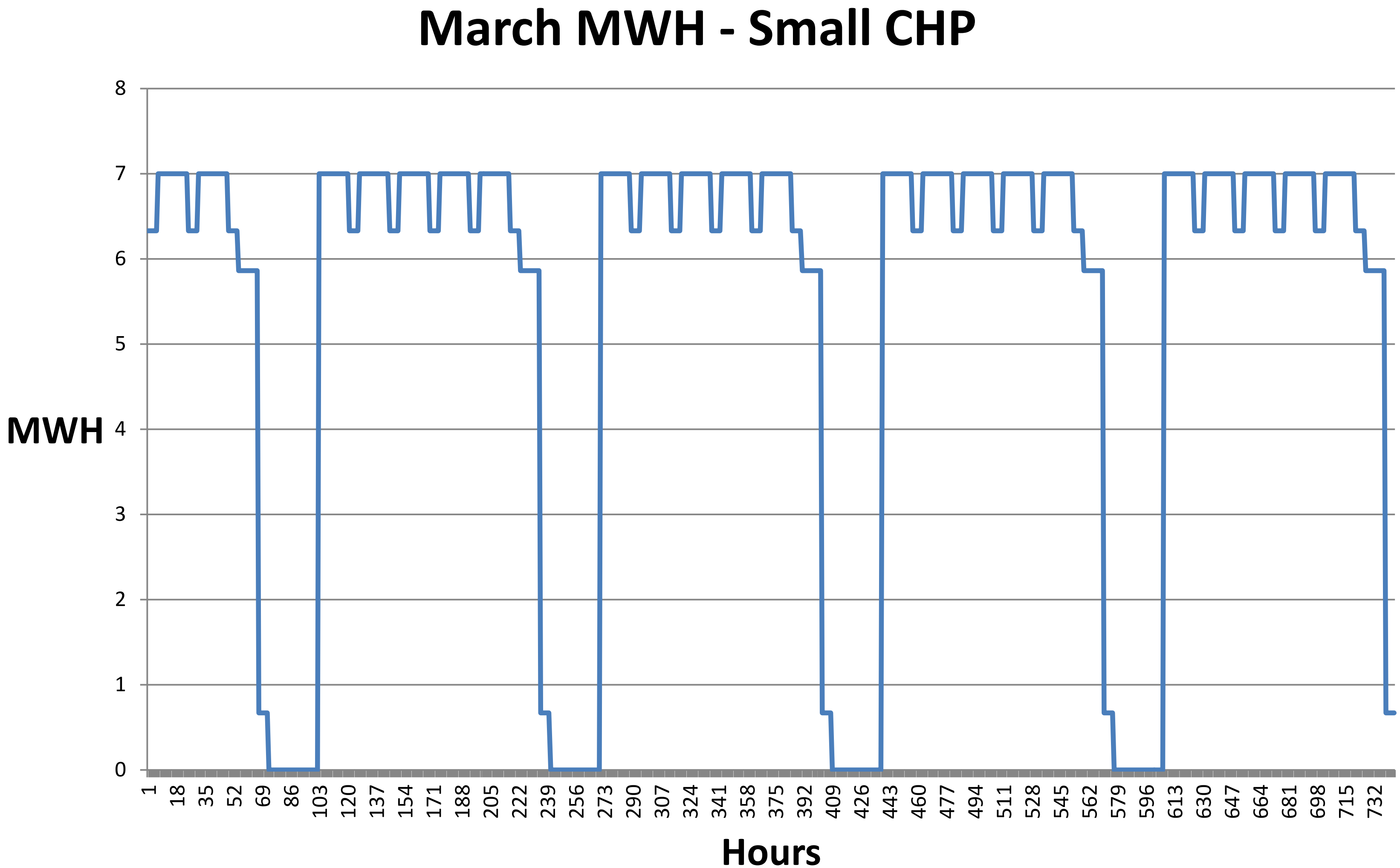
Small CHP

Type	Total Fuel MMBTU/Hr.	Fuel for Thermal Output MMBTU/Hr.	Capacity Factor	Net Heat Rate BTU/kWh
Gas Turbine	66.3	29.7	78.6%	7,048#
Large Engine	10.64	4.10	71.5%	5,755
Micro Turbine	6.975	2.74	64.4%	7,434
Small Engine	1.26	0.67	64.4%	5,928

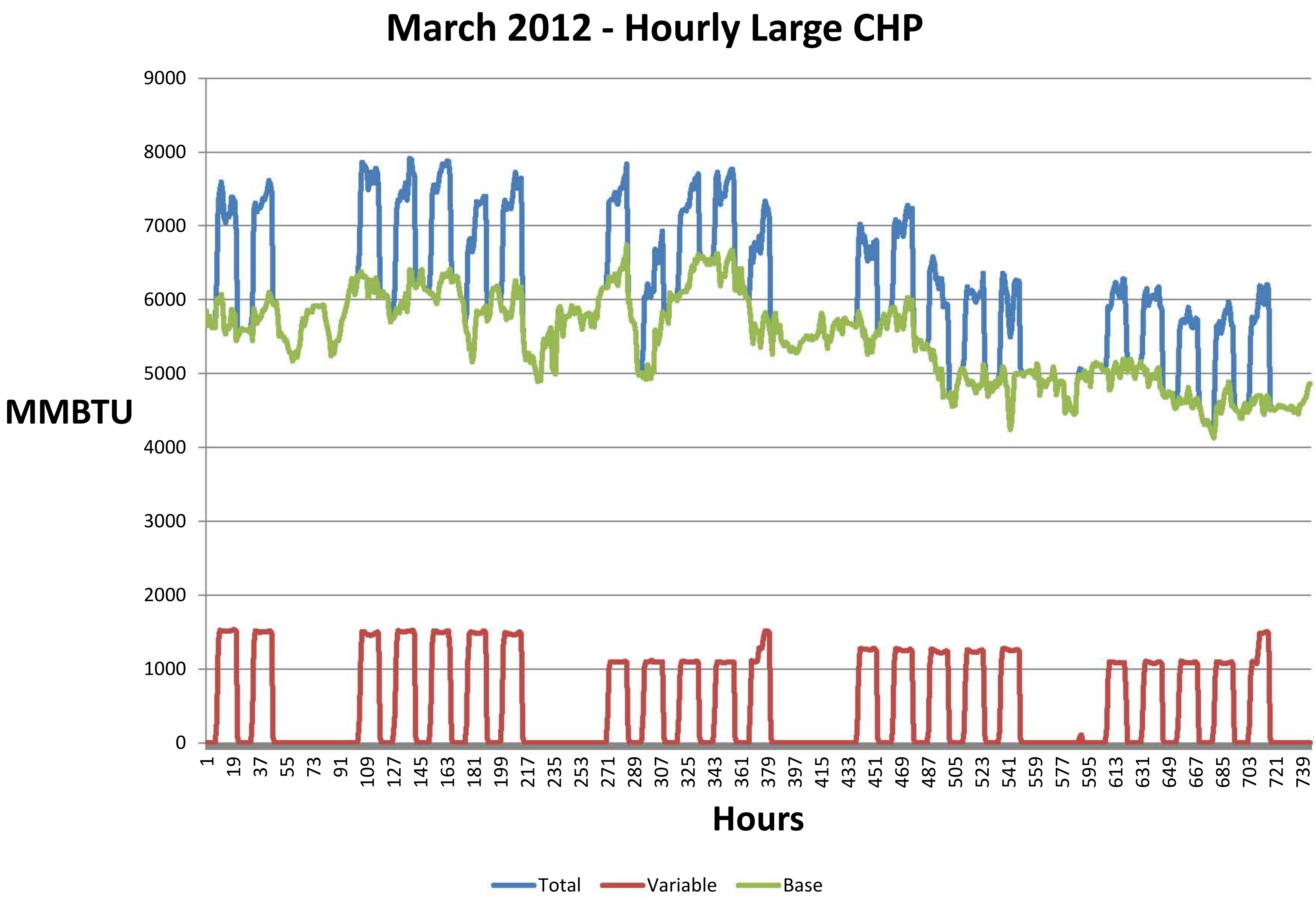
(66.3-29.7)*10^6/5,193

Small Gas Turbine 5,193 kW; Large Reciprocating Engine 1,137 kW; Micro Turbine 570 kW; Small Engine 100 kW

Small CHP Load Profile



Large CHP Gas Load Profile



Production Simulation Model Results

Fuel Use and GHG Related to Non-Export CHP

	Non Export Fuel BCF	Increase in CO_2 MMT	T&D Fuel Savings BCF	Reduction in CO_2 MMT	Boiler Fuel Savings BCF	Reduction in CO_2 MMT
Small CHP	44.67				8.46	0.449
Large CHP	37.40				11.74	0.623
Total	82.07	4.357	5.66	0.301	20.20	1.072

Production Simulation Model Results

Fuel Use and GHG Reduction

Scenarios	Imports GWH	Reduction in Imports GWH	Reduction in CO_2 MMT	Total Fuel BCF	Reduction in Total Fuel BCF	Reduction in CO_2 MMT
Base	71,457			787.694		
One	62,013	9,444	4.123[1]	750.832	36.862	1.957
Two	65,149	6,308	2.754	756.958	30.736	1.632

1) 9,444*0.428*1.02, where 0.428 is ARB CO_2 tons per MWh from unspecified sources adjusted for 1.02 losses.

CO_2 savings

Scenario One : 4.123 + 1.957 +0.301 +1.072 – 4.357 = 3.10 MMT

0.667*6.7 = 4.47 3.10/4.47 = 69%

Scenario Two: 2.754 + 1.632 +0.301 +1.072 – 4.357 = 1.40 MMT

1.40/4.47 = 31%

Conclusions

- As the grid becomes greener and the GHG intensity per MWH falls, predictions of large reductions in CHP's effectiveness to reduce GHG emissions are over stated.
- Determining the real effectiveness of CHP to reduce GHG emissions requires new CHP be evaluated within the operational context of the whole electric system.
- The analysis shows that the emissions reduction capability of CHP, while reduced, is still substantial and should not be dismissed.
- CHP reduces GHG emissions levels of the California grid and will continue to do so in the future.
- The 'greening of the grid' should not preclude CHP from remaining an integral part of California's GHG reduction strategy.